REMARKS

Claim Amendments

The term "gear" added to the claims is supported in the specification on page 1, line 1 and original claim 10.

Editorial revisions were made to claim 8.

The amendment to claim 17 involving "300°C to the A1 temperature" is supported on page 31, line 12 of the specification.

New claim 25 replaces previous claim 18 and recites features recited in claim 17 and which were previously recited in claim 19.

New claim 26 recites features that were previously recited in claim 19.

New claims 27 to 29 recite features recited in claims 20, 22 and 24, respectively.

Allowable Subject Matter

Applicants are pleased to note that claim 9 was considered to contain allowable subject matter (see item nos. 23 to 24 on pages 6 to 7 of the Office Action).

Rejection Under 35 USC 112, First Paragraph

Claim 17 was rejected under 35 USC 112, first paragraph, for the reason set forth in item no. 4 bridging pages 2 to 3 of the Office Action.

Claim 17 was amended to delete subject matter that was stated in the Office Action to be new matter.

Withdrawal of the 35 USC 112, first paragraph rejection is respectfully requested.

Rejection Under 35 USC 112, Second Paragraph

Claim 10 was rejected under 35 USC 112, second paragraph, for the reasons set forth in item nos. 7 to 9 on page 3 of the Office Action.

It is respectfully submitted that the following explanations serve to overcome all the grounds for the 35 USC 112, second paragraph.

Claim 10 was amended in reply to the above rejection under 35 USC 112, second paragraph.

The following explanation is provided to clarify claim 10.

Module and Diametral Pitch

Module

For indicating the size of a gear (tooth), a module is most widely used. Module M (mm) is obtained by dividing the pitch diameter d (mm) by the number of teeth z, namely, M = d/z.

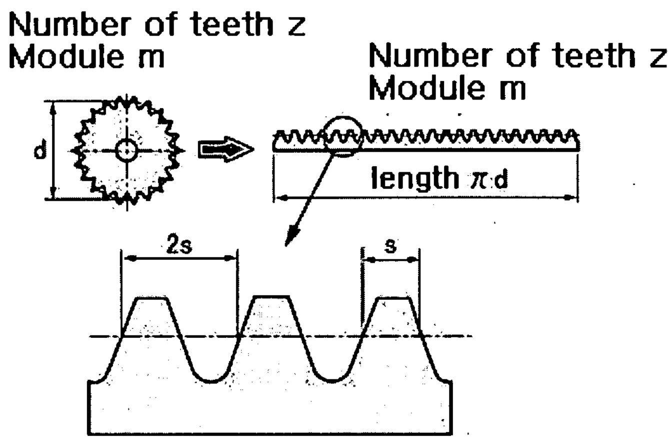
The larger the number M is, the larger the size of the tooth becomes. The measurement unit is mm. Enclosed is an article obtained from the MISUMI USA INC. website, which describes the relationship between the module, the pitch and the number of teeth.

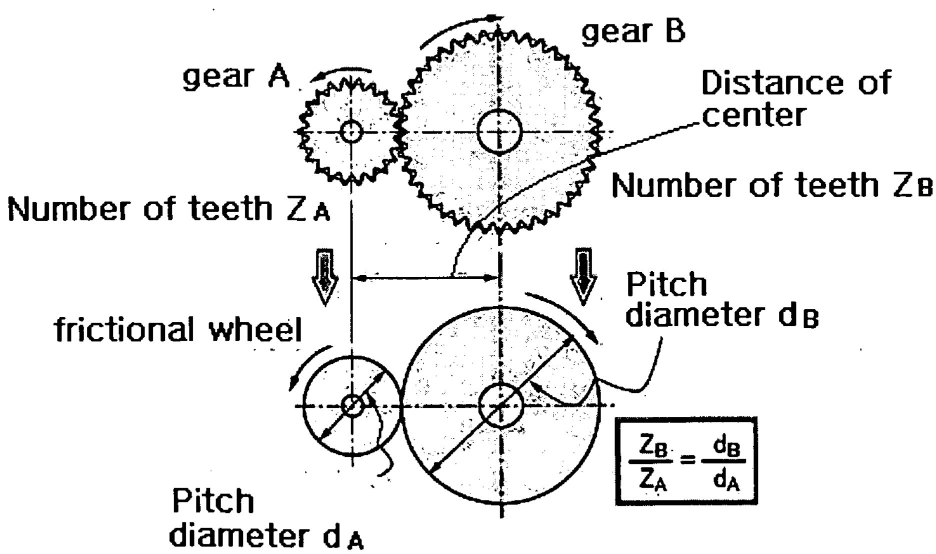
Diametral Pitch

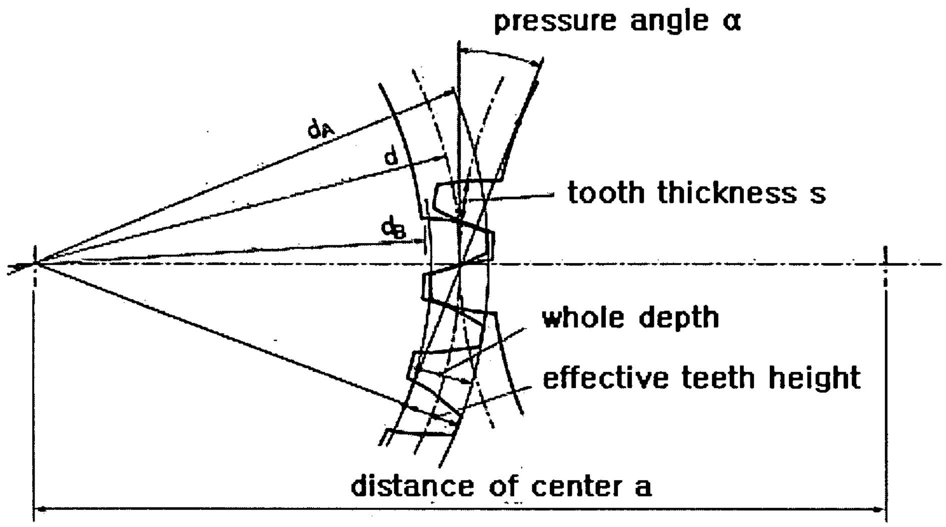
Diametral pitch (P) is defined as the number of teeth per inch (=25.4mm) of a gear's pitch diameter.

P = number of teeth / pitch diameter (in inches) = z/d

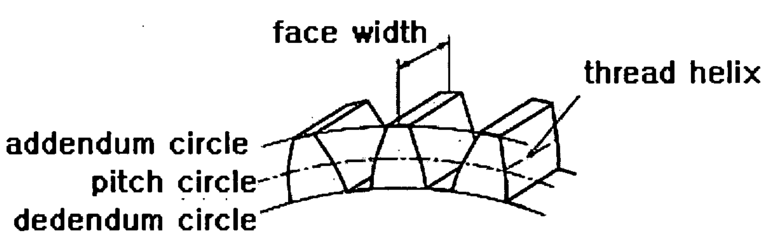
The above discussion is illustrated in the following drawings:







dA :addendum circle diameter
d :pitch diameter
dB :dedendum circle diameter



The following is stated on pages 27 to 28 of the present specification:

(i) By heating the steel in a temperature range from the A1 temperature to 550°C (this temperature range is in the two phase (ferrite + cementite) region), alloy elements such as Cr, Mn and Mo contained in steel are concentrated in the cementite, and the concentrations of the Cr, Mn and Mo in the ferrite are largely lowered.

(ii) The Cr concentration in the cementite is adjusted to 2.5 to 20 wt%, and by rapid heating (induction heating), the ferrite is transformed into austenite with the cementite being partially solid-dissolved. Before the alloy elements in the cementite have been homogeneously dispersed in the austenite, carbon in the cementite is rapidly and homogeneously dispersed in the austenite, and the carbon concentration in the austenite is adjusted to 0.3 to 0.8 wt%. Thereafter the steel is subjected to rapid cooling such that the austenite is transformed into martensite.

(iii) Therefore, hardenability in the applicants' present claim 10 clearly means hardenability of the steel obtained as a result from the alloy element concentrations in the ferrite and the

aforesaid 0.3 to 0.8 wt% concentration of carbon in the austenite. It is noted that the chemical composition of the martensite phase and that of the austenite phase in the present specification are the same, and the DI value is obtained from this chemical composition. Applicants' present claim 10 recites hardenability of the martensite phase, which was previously a ferrite phase. The present specification discusses the hardenability of the austenite phase. These are recitations in view of the chemical compositions of martensite and austenite, which are parent phases of a double phase structure after quenching (martensite + cementite) and that are before quenching (austenite + cementite) respectively. But they are essentially the same. These recitations are made in view of the chemical composition of a steel material which is different.

Attention is directed to the following article: THE HARDENABILITY OF STEEL by Mike Meier (Department of Chemical Engineering and Materials Science, University of California, Davis) dated September 13, 2004. A copy of the aforesaid article was enclosed with the AMENDMENT UNDER 37 CFR 1.111 filed August 3, 2007. According to the aforesaid article, the DI value (Ideal Diameter) is a measure of the hardenability of steel. It is

defined as the diameter of a bar which would contain 50% martensite at its center following a quench in an ideal medium. Clearly, the larger the ideal diameter, the higher the hardenability of the steel. The ideal diameter of a plain carbon steel having a carbon content of 0.4% (1040 steel) and whose ASTM grain size number is 7 is 0.214 inches. Naturally, varying the grain size or changing the concentration of alloying elements will change the ideal diameter. As seen from the aforesaid article, the unit of measure of the DI value is inches.

Withdrawal of the 35 USC 112, second paragraph rejection is therefore respectfully requested.

Obviousness Rejection Under 35 USC 103

Claims 1, 3 to 8, 10 to 15, 17 to 20 and 22 to 24 were rejected under 35 USC 103 as being unpatentable over USP 3,663,314 (Monma et al.) alone or in view of US 2002/0029597 (Choe et al.) or the English-language abstract of JP 408081738 for the reasons set forth in item nos. 11 to 22 on pages 4 to 6 of the Office Action.

It was admitted in the Office Action that the Cr concentration of cementite of 2.5 to 10 wt% recited in claim 1 is not taught by the references.

It was admitted in the Office Action that Monma et al. do not disclose pearlite or retained austenite as recited in applicants' claims 4 and 5.

It was admitted in the Office Action that a prior austenite grain size of ASTM grain size No. 10 or higher recited in applicants' claim 6 is not taught by the references.

It was admitted in the Office Action that the prior art does not teach shot peening as a finishing step to produce a residual compressive stress on the surface of a rolling bearing element, as recited by one or more of applicants' dependent claims.

It was admitted in the Office Action that the DI formula recited in applicants' claim 10 is not taught by the prior art.

It was admitted in the Office Action that the prior art does not specifically add 0.1 to 5 wt.% V as recited in applicants' claims 23 and 24.

Monma et al. are directed to a bearing steel consisting of component elements in predetermined amounts which is heated at a

proper temperature region (810 to 870°C) for 30 minutes in a furnace. It is clear that the properties of the bearing steel of Monma et al. is obtained only when this specific heat treatment condition is met. It is clear that if this heat treatment is applied to a gear, at least a tooth section is entirely heated by heating at 810 to 870°C for 30 minutes. After oil quenching, the tooth section is through-hardened and the following problems arise: (a) a compressive residual stress can be hardly imparted to the tooth section surface and (b) quenching distortion becomes larger. Further, it is necessary to change the heat condition in accordance with different sizes of gears. However, such technical condition is not disclosed sufficiently in Monma et al., and as such, the size of the gear to be heat-treated is quite limited.

The presently claimed invention is characterized in that a surface layer of a gear is subjected to induction heating, in which the gear is rapidly heated at 900 to 1100°C within ten seconds along a tooth contour, and then it is rapidly cooled, thereby a case-hardened layer is formed along the tooth contour. Also, in order to control the solid-dissolved carbon

concentration in a martensite parent phase in the case-hardened layer to be 0.25 to 0.8 wt%, as well as to control an amount of solid-dissolved cementite by the rapid heating, the Cr concentration in the cementite is controlled to be 2.5 to 10 wt%.

It is clear that Monma et al. do not teach heating conditions to allow cementite that is not solid-dissolved to remain, or a Cr concentration in the cementite in connection therewith.

Monma et al. also do not provide any basis for easily estimating the amount of cementite that is not solid-dissolved, or the solid-dissolved carbon concentration in the martensite as a result of the heat treatment under specific conditions along the tooth contour.

Further, in the disclosure regarding the role of Cr as an alloy element (see column 7, lines 47 et seq. of Monma et al.), there is no statement concerning the influence that Cr has on the cementite not being solid-dissolved, and it is not clear how to provide an alloy therefrom.

In addition, Table IV of Monma et al. at the bottom of columns 3 to 4, shows that alloy No. 12 contains 0% of the

cementite, whereas Table 4 on page 47 of the present specification shows that from alloy No. W1, cementite particles that are not solid-dissolved remain. Therefore, it is clear that by different heat-treating methods, the residual volume of the cementite which is not solid-dissolved differs.

It is respectfully submitted that none of the cited references alone or combined in the manner set forth in the Office Action render applicants' present claims obvious.

Withdrawal of the 35 USC 103 rejection is respectfully requested.

Reconsideration is requested. Allowance is solicited.

A Form PTO-2038 in the amount of $208 is enclosed herewith in payment of four additional total claims. Any additional fees or overpayments are hereby authorized to be charged to Deposit Account 06-1378.

If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the

undersigned at the telephone number given below for prompt action.

Respectfully submitted,

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Encs.: (1) PETITION FOR EXTENSION OF TIME

(2) copy of article from the MISUMI USA INC. website (two sheets)

(3) Form PTO-2038

Metric and Inch Spur Gears

For metric gears the gear proportions are based on the module. Modules is the ratio of the "Pitch Diameter" to the "Number of Teeth".

m (module)= d (pitch diameter (mm)) / N (number of teeth)

When module (m) number for metric gears is getting bigger- size of the teeth is getting bigger too.

In the USA the module is not used and instead the "~~Diametric~~ Diametral Pitch" or "Pitch" (p) is used.

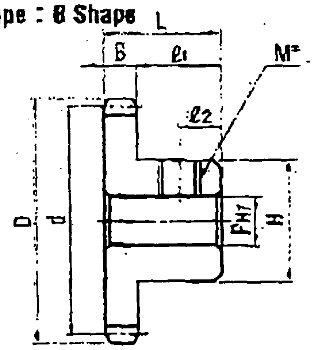
p= N (number of teeth) / d (pitch diameter (Inch))

When pitch (p) number for inch gear is getting bigger- size of the teeth is getting smaller.

Calculation example: Having two dimensions for each gear we will try to find number of teeth (N) using above equations:

Metric gear:
Φ (pressure angle)= 20°
m (module)= 0.8
N (number of teeth)= ?
d (pitch diameter)= 16 [mm]

Tooth Shape : B Shape



m= d/N ↔ N= d/m ↔ N= 16/0.8= 20

Inch gear:
Φ (pressure angle)= 20°
p (pitch)= 32
N (number of teeth)= ?
d (pitch diameter)= 0.625"

p= N/d ↔ N= p*d ↔ N= 32*0.625= 20

Conclusion: for both spur gears we calculated same number of teeth. Converting inch

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dimensions to metric (1"= 25.4mm) we can see how close these two gears are:

Knowing pitch (p) for inch gears we can simply calculate inch module:

$$m= (1"/32)= 0.03125$$

Or knowing pitch diameter (d) and number of teeth (N):

$$m= d/N= 0.625/20= 0.03125$$

Lets convert Inch module m= 0.03125 to metric using (1"= 25.4mm) converter from Inch to Metric dimensions.

$$0.03125 * 25.4= 0.794$$

Conclusion: We can see that the metric and inch spur gears are dimensionally very similar but we **should not** mesh them together duo to small differences developed during design and manufacturing stage.

Posted by Misumi USA at 08/08/2008 10:59:23 AM |

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